UNITED STATES PATENT AND TRADEMARK OFFICE

Appellant:	William Arthur Welsh
Serial No.:	10/685,053
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Group Art Unit:	3683
Examiner:	Nguyen, Xuan Lan
Title:	ACTIVE FORCE GENERATION/ISOLATION SYSTEM EMPLOYING MAGNETO RHEOLOGICAL FLUID (MRF)

Commissioner for Patents
Mail Stop Appeal Brief-Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Dear Sir:

Appellant submits this Appeal Brief pursuant to the Notice of Appeal filed 29 September 2006 and the notice of non-compliance dated 2-14-2007.

I. REAL PARTY IN INTEREST

The real party in interest is **Sikorsky Aircraft Corporation**, assignee of the present invention.

II. RELATED APPEALS AND INTERFERENCES

There are no prior or pending appeals, interferences or judicial proceedings which may directly affect or may be directly affected by or have a bearing on the Board's decision in this appeal.

III. STATUS OF CLAIMS

Claims 24-28, 33 are 34 stand allowed.

Claims 18, 22 and 23 are allowable but objected to for being dependant upon a rejected claim.

Claims 12-18 and 20-34 are pending are pending, rejected and appealed.

IV. STATUS OF AMENDMENTS

All amendments have been entered.

V. SUMMARY OF CLAIMED SUBJECT MATTER

Vibration isolation and absorption is often desirable for nulling or canceling vibrations associated with a rotating system. One application which best exemplifies the need for and advantages derived from vibration isolation/absorption devices is the helicopter main rotor system. Typically, the main rotor system is subject to a variety of aerodynamic and gyroscopic loads that generate substantial in-plane and out-of-plane vibrations, which, if not suppressed, isolated or otherwise abated, are transmitted to the cockpit and cabin, typically through the mounting of the helicopter main rotor gearbox. [¶¶0002-0003]

The present application relates to a vibration isolation system 10 mounted to a main rotor system that employs a Magneto Rheological Fluid (MRF) as the working inertial mass. Magneto-Rheological Fluid (MRF) is a composition that changes state, i.e., from fluid to solid or solid to fluid, depending upon the magnitude of an electrical field, i.e., when the MRF is exposed an electromagnetic field. The MRF isolation system minimizes system weight, aerodynamic drag, and complexity while concomitantly providing active control and adjustment during operation for optimal efficacy across a wide spectrum of operating speeds. [¶¶0001 and 0024]

The vibration isolation system 10 of the present invention is described in the context of a helicopter rotor system, such as that employed in an Army BLACK HAWK helicopter produced by Sikorsky Aircraft Corporation. [¶0021]

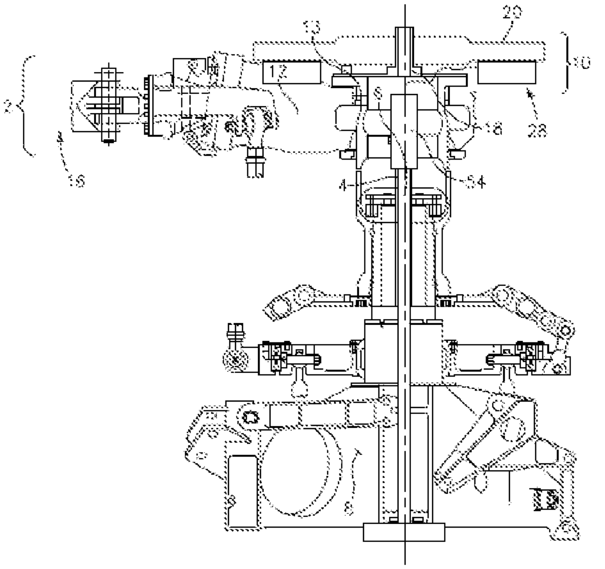


FIG. 2

The MRF vibration isolation system 10 is disposed in combination with a helicopter main rotor system 2 including a main rotor shaft 4 which is driven about a rotational axis 6 by a torque driving transmission 8. The main rotor system 2 includes a rotor hub 12 having radial arms, which mount to and drive each rotor blade 16. The vibration isolation system 10 is mounted to a flanged segment 13 of the main rotor shaft 4 through a hub attachment fitting 18. Vibratory forces active on the main rotor system 2 are generated by a variety of factors, although the dominant vibrations originate from aerodynamic and/or gyroscopic forces from the rotor blades 16. [¶0022]

A four bladed rotor system produces 4P vibratory loads. In a single revolution, the magnitude of the load vector varies from a minimum to a maximum value four times. While a variety of factors influence the vibratory spectrum of a rotor system, such 4P vibrations are generally a result of each rotor blade experiencing maximum lift when advancing and minimum lift when retreating. This vibration frequency can be more generally depicted by the term NP where N is the number of blades and P is the rotational speed of the rotor hub 12 of the helicopter main rotor system 2. [¶0022]

The vibration isolation system 10 includes a housing 20, an enclosed chamber 22 containing an MRF 26, a field generation system 28 for controlling the distribution of the MRF 26, a drive system 30 for driving the enclosed chamber 22 about the rotational axis of the rotor shaft 4, and a power generator system 60 for powering the field generation system 28 and drive system 30.

The drive system 30 includes: a field generation system 28 capable of producing an electromagnetic field within the chamber 22, an electric motor 34 for displacing the MRF 26 within chamber, and a control system 40. In a preferred embodiment, the field generation system 28 includes a multiple of electromagnets 32 disposed about the periphery of the enclosed chamber 22. The field generation system 28 and the drive system 30 provides a selective build-up of MRF 26 in a desired radial location within the chamber 22 (Figures 3A-3C). The control system 40 selectively varies the flux of the electromagnetic field generated by the multiple of electromagnets 32 to produce the magnetic field about the chamber 22 in response to flux field signals 48s indicative of strength and phase of the electromagnetic flux field to establish and/or alter the azimuthally varying viscosity of the MRF 26. Further, drive control signals 44s are issued to the drive system 30 for varying the speed and phase of the chamber 22 within the housing 20. [¶0023]

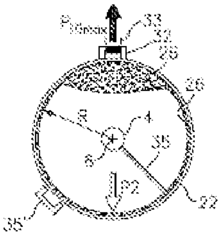


FIG. 3a

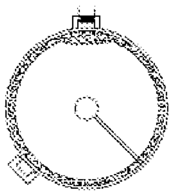


FIG. 3b

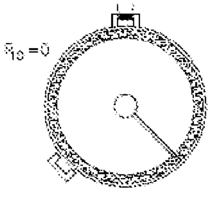


FIG. 3c

Figures 3a-3c show that a large flux field signal 48s to the field generation system 28 will result in a significant accumulation of MRF 26 and thus a larger eccentric mass (Figure 3A). A zero signal will result in no accumulation thus the centrifugal forces will cause the MRF 26 to distribute uniformly on the chamber inner periphery producing zero vibratory force (Figure 3C). [¶0026]

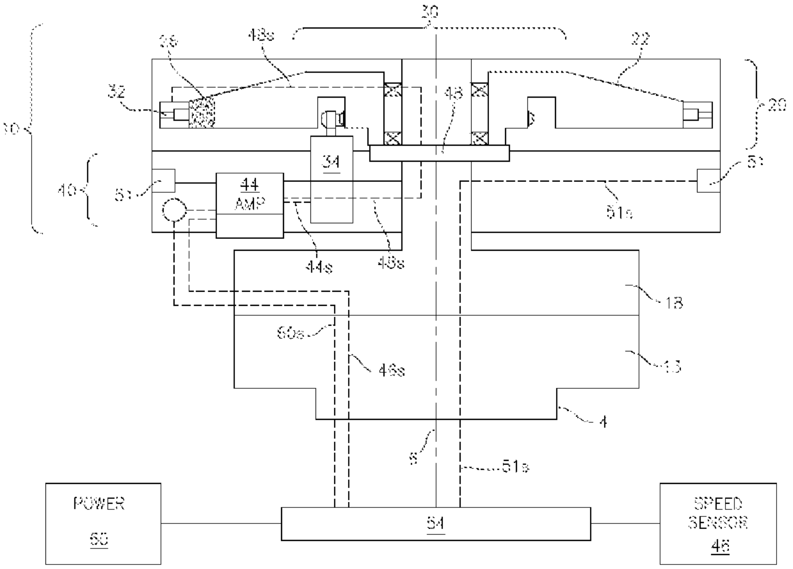


FIG. 4

The electric motor 34 independently drives the chamber 22 about the axis of rotation 6 of the main rotor shaft 4. In the preferred embodiment, the drive system 30 includes an electric motor 34 for driving the chamber 22. The drive system 30 is responsive to control signals issued by the control system 40. More specifically, the control system 40 includes: a speed sensor 46 for obtaining input speed signals 46s indicative of the rotational speed 1P of the main rotor shaft 4, and a signal amplifier 44, responsive to the input speed signals 46s, for issuing control signals 44s to the drive system 30. [¶0027]

In operation, the MRF 26 is solidified or frozen in a particular position and, as such, functions as the working or inertial mass of the system 10. More specifically, the MRF 26 is (i) disposed at a predetermined distance R from the main rotor shaft axis of rotation 6, (ii) driven in the same or opposing rotational direction as the main rotor shaft axis of rotation 6 and (iii) driven at a rotational speed greater than the rotational speed 1P of the rotor shaft. While the speed sensor 46 may be a dedicated unit for sensing rotor speed, the same information may be obtained from a transmission driven alternator or generator 60 (Figure 4), which turns at a predefined speed relative to the rotor speed. The power source 60 is preferably a 15 kVa generator which provides a 115 volt, 400 Hz 3 phase potential drives the electric motor 34 and simultaneously provides the reference signal. The generator is mechanically driven by the torque driving transmission 8. As a result, the rotational speed of the generator is a fixed multiple of the speed of the driving gear in the gearbox and of the main rotor NP frequency. The electrical phase of the generator voltage is a fixed multiple of the generator rotational speed. Thus, the electrical voltage phase signal is a reflection of the NP frequency. As the rotor speed and NP frequency vary while in flight, the electrical voltage phase signal also varies and is perfectly slaved, i.e., a fixed multiple of the rotor speed. This makes the voltage signal a good reference signal that will exactly track rotor speed. Hence, the control system 40 may use phase information from such devices to issue the appropriate control signals to the drive system 30 and to the field generation system 28. [¶0028]

While the vibration isolation system 10 may employ a control system 40 having a predefined schedule or model of the vibrations, e.g., at prescribed rotor speeds, the preferred embodiment also employs a vibration sensing device or system. As such, the control system 40 includes one or more vibration feedback sensors 51 for issuing vibration signals 51s indicative of the vibrations (e.g., amplitude, frequency and phase) in the helicopter, e.g., fuselage, cabin or cockpit. The control system 40 samples vibration levels at predefined intervals or rates to identify a trend - positive (lower vibration levels) or negative (larger vibration levels). Accordingly, as vibration levels change, the control system 40 issues modified control signals 44s and 48s to the drive system 30 and the field generation system 28 until a combination of rotational speed and angular position of the MRF 26 center of gravity are achieved to minimize vibratory loads in the main rotor system 2. [¶0029]

The vibration isolation system 10 may be powered by any of a variety of known methods, especially methods which may require transmission from a stationary to a rotating reference system. In the described embodiment, the power source 60 for the drive system 30, the control system 40, and the field generation system 28 is the 15 kVa generator which provides a 115 volt, 400 Hz 3 phase potential. [¶0030]

The MRF 26 is driven at a rotational speed greater than the rotational speed of the main rotor system 2 and appropriately positioned to yield a load vector P_{10} (Figure 3A) which is equal and opposite to the vibration load vector P2 produced by the main rotor system 2. This counteracting load vector P_{10} can be viewed as a vector which attempts to cancel or null the displacement of the rotor shaft 4. Inasmuch as the drive system 30 is mounted directly to the rotating shaft 4 of the main rotor system 2, the drive system 30 need only drive the chamber 22 at three additional revolutions per cycle (for each revolution of the rotor system) in the direction of rotation of the main rotor system 2 to achieve the desired 4P operating frequency for a 4 bladed rotor. That is, since the MRF 26 is, in the rotating reference system, driven at one revolution per cycle by the main rotor system 2 itself, the drive system 30 need only augment the rotational speed 1P of the main rotor system 2 by 3P, provided that the augmentation is in the same rotational direction, to achieve the necessary 4P (computed by 1P+3P = 4P) frequency relative to the stationary reference system. Alternatively, the augmented rotation can be opposite to the rotor speed 1P. For example the drive system 30 can augment the rotational speed 1P by rotating the chamber 22 at 5P in the opposite direction to achieve the necessary 4P (computed by 1P-5P = -4P) frequency in the stationary reference system. For any number of rotor blades, the absolute frequency to suppress is NP where N is the number of rotor blades. The augmentation speed of the chamber 22 produced by the drive system 30 is then (N-1)P in the direction of the rotor speed or (N+1)P in the opposite direction. [¶0031]

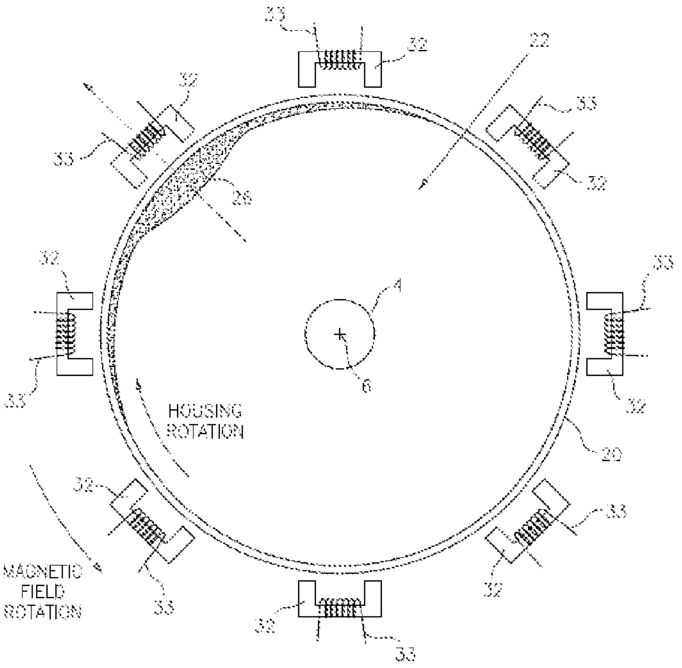


FIG. 5

The embodiment of Figure 5 has the advantage of not requiring an electrical slip ring 54. In this embodiment, the electro-magnets 32 do not rotate with the chamber 22 (Figure 4). The shaft 4 and the chamber 22 rotate together and in the counterclockwise direction at a frequency of 3P, for a 4 bladed rotor, relative to the main rotor system 2. The rotation of the shaft 4 about the axis of rotation 6 at a frequency of 3P is achieved with an electric motor. The electric power to the power coils 33 is switched to the successive electromagnets 32 in the counterclockwise direction such that the magnet field rotates at the same rotational speed as the shaft 4 and chamber 22. As a result, the maximum magnetic field rotates at the same rotational speed as the chamber 22 and is thus stationary relative thereto. As a consequence, the MRF 26 accumulates in the chamber 22 at a point of the maximum magnet field. In this manner, the bulk of the MRF 26 forms an eccentric mass according to the commanded phase of the magnetic field position. The resulting eccentric mass causes an eccentric centrifugal force that can be adjusted to suppress the unwanted ambient force. [¶0032]

Lessening or increasing the amount electrical current applied to the power coils 33 varies the amount of MRF 26 that accumulates at a chosen angular location in the housing 22. When the current is zero or very low, the MRF 26 is distributed uniformly around the periphery of the chamber 22 (Figure 3C). As the amount of current sequentially applied to the power coils 33 of the electromagnets 32 is increased, the amount of MRF 26 that accumulates at the chosen azimuth phase in the chamber 22 will increase, thus causing a correspondingly large eccentric force to suppress an unwanted ambient force. [¶0033]

Independently varying the location and magnitude of the MRF 26 within the housing 20 is especially valuable in applications wherein the magnitude of the vibratory load active in/on the rotating system varies as a function of operating regime or operating speed. In a rotorcraft, for example, it is common to require the highest levels of vibration isolation in high speed forward flight i.e., where the rotor blades are experiencing the largest differential in aerodynamic loading from advancing to retreating sides of the rotor system. Consequently, it may be expected that the vibration isolation system 10 produce a maximum load vector P10max (Figure 3a). In another example, it is anticipated that the lowest levels of vibration isolation would be experienced in a loiter or hovering operating mode, where the rotor blades are exposed to the same aerodynamic and gyroscopic affects. Consequently, it may be expected that the vibration isolation system 10 produce a minimum load vector, P10min (Figure 3c). [¶0035]

In summary, the vibration isolation system 10 is capable of nulling or canceling vibrations across a wide frequency spectrum. That is, the vibration isolation system 10 is capable of varying its operating frequency irrespective of changes in operating regime or operating speed. [¶0036]

Summary of Claim 12

Claim 12 recites:

12. A vibration isolation system for reducing vibrations in a rotating system which rotates about an axis of rotation, comprising:

> an enclosed chamber mounted to the rotating system for rotation about said axis of rotation independent of the rotating system;
>
> a Magneto Rheological Fluid (MRF) at least partially filling said enclosed chamber; and
>
> an electromagnetic field generation system mounted adjacent said enclosed chamber to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber to reduce a vibratory load in said rotating system.

Thus, referring in particular to Figure 4, claim 12 recites an enclosed chamber 22 mounted to the rotating system (helicopter main rotor system 2) for rotation about the axis of rotation 6 independent of the rotating system (helicopter main rotor system 2) such that the vibration isolation system 10 azimuthally varies a viscosity of said MRF to distribute said MRF within said enclosed chamber to reduce a vibratory load in said rotating system (helicopter main rotor system 2). [see ¶0027]

Summary of Claim 21

Claim 21 recites:

21. A helicopter rotor system which rotates about an axis of rotation, comprising:
a main rotor system having an N number of blades which rotates about an axis of rotation at a rotational speed of 1P, such that said main rotor system produces NP vibrations;
an enclosed chamber mounted to said main rotor system for rotation about said axis of rotation independent of said main rotor system;
a Magneto Rheological Fluid (MRF) at least partially filling said enclosed chamber;
a sensor system which senses the NP vibrations;
a control system in communication with said sensor system, said control system operable to identify variations of the NP vibrations; and
an electromagnetic field generation system mounted adjacent said enclosed chamber to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber to form an eccentric mass in response to said control system to reduce said NP vibrations.

Thus, in addition to the limitations of Claim 12, Claim 21 is specifically directed to a helicopter rotor system with a main rotor system having an N number of blades and specifically recites that the enclosed chamber 22 is mounted to said main rotor system for rotation about said axis of rotation independent (rotational speed of 22 would be NP) of said main rotor system to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber to reduce a vibratory load in said rotating system. [See ¶[¶ 0028-0030] Claim 21 also specifically recites a sensor system and a control system to identify variations of the NP vibrations such that the eccentric mass may be formed essentially in real time in response thereto.

Summary of Claim 24

Claim 24 recites:

24. A method of reducing vibrations in a helicopter rotor system which rotates about an axis of rotation comprising the steps of:

(1) rotating an enclosed chamber mounted to a main rotor system about the axis of rotation independent of the main rotor system, the enclosed chamber at least partially filled with a Magneto Rheological Fluid (MRF);

(2) sensing a vibration generated by the main rotor system;

(3) varying an electromagnetic field about the enclosed chamber to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber to form an eccentric mass in response to said step (2) to reduce the vibration; and

(4) varying an electric motor speed that rotates the enclosed chamber to match an optimal phase relative the vibration in response to controller commands.

Claim 24 stands ALLOWED. Claim 24 is specifically directed to a method of reducing vibrations in a helicopter rotor system by the azimuthal variation of a viscosity of said MRF to distribute said MRF within said enclosed chamber to form an eccentric mass in response to said step (2) to reduce the vibration by varying an electric motor speed that rotates the enclosed chamber to match an optimal phase relative the vibration. [See ¶¶ 0028-0033]

Summary of Claim 33

Claim 33 recites:

> 33. A helicopter rotor system which rotates about an axis of rotation, comprising:
>
> a main rotor system having an N number of blades which rotates about an axis of rotation at a rotational speed of 1P, such that said main rotor system produces NP vibrations;
>
> a housing mounted to said main rotor assembly;
>
> an enclosed chamber mounted within said housing for rotation about said axis of rotation independent of said main rotor assembly;
>
> an electric motor located within said housing to drive said enclosed chamber about said axis of rotation independent of said main rotor assembly;
>
> a Magneto Rheological Fluid (MRF) at least partially filling said enclosed chamber;
>
> a sensor system which senses the NP vibrations;
>
> an electromagnetic field generation system mounted adjacent said enclosed chamber to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber to form an eccentric mass; and
>
> a control system in communication with said sensor system, said electric motor, and said electromagnetic field generation system, said control system operable to identify variations of the NP vibrations to control a rotational speed of said enclosed chamber and said electromagnetic field generation system to control distribution of said MRF within said enclosed chamber to reduce the NP vibrations.

Claim 33 stands ALLOWED. Thus, in addition to the limitations of Claim 21, Claim 33 including a control system operable to identify variations of the NP vibrations to control a rotational speed of said enclosed chamber and said electromagnetic field generation system to control distribution of said MRF within said enclosed chamber to reduce the NP vibrations. [See ¶[¶ 0028-0033

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 12-17, 20, 21, and 29-32 were rejected under 35 U.S.C. §103(a) as being unpatentable over *Hooper* in view of *Case et al.*

VII. ARGUMENT

§103(a) REJECTIONS

Claims 12-17, 20, 21, and 29-32 stand finally rejected under 35 U.S.C. §103(a) as being unpatentable over *Hooper* in view of *Case et al.*

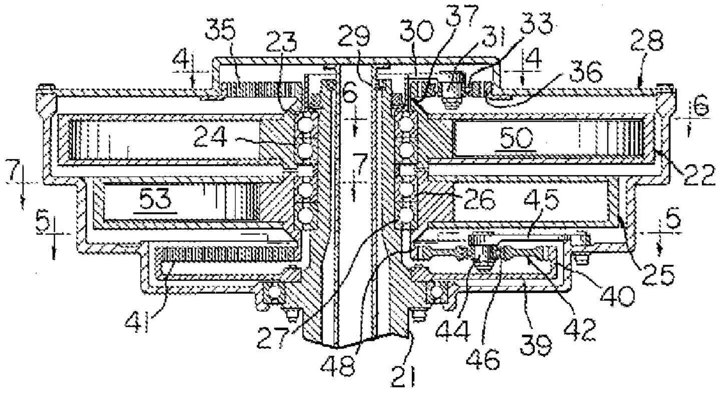
Claims 12-17, 20, 21, and 29-32

A. THE COMBINATION OF *HOOPER* IN VIEW OF *CASE* IS IMPROPER FOR AT LEAST THE FOLLOWING REASONS:

I. Impermissible Usage Of Hindsight To Modify *Hooper* In View Of *Case*

The entire rejection must fail as there is absolutely no teaching, suggestion, or motivation to modify *Hooper* in view of *Case et al. Hooper* discloses a mechanical vibration absorption system for a rotary wing aircraft or a propeller like device having a rotating hub and a plurality of radial members. [See *Hooper*, Col. 8, lines 49-55]. *Hooper* makes no mention of MRF, or the electromagnetic shifting of MRF.

FIG.3



The vibration absorption system of *Hooper* is completely based on a mechanical gear arrangement. *Hooper's* masses (50 and 53) automatically orient themselves in their respective chambers 22 and 25 due to the ambient vibration so that that vibration is suppressed. The positions of the masses in

22 and 25, which will determine the amount of anti-vibration force, is not controlled in any way but relies upon physics to provide a tuned absorber effect. (Conversely, Appellant directly controls the size and phase of the anti-vibration force.)

Case discloses an imbalance compensator for rotating machine tool shafts. *[See Case ¶0008]* *Case* utilizes a balance ring 40 affixed or fixtured to the shaft 20 proximate the motor 18 to compensate for an eccentric load on a driven shaft to reduce vibrations and enhance the consistency of loading on the shaft. Notably, the balance ring 40 is a separate component removably mounted to the driven shaft 20 but is not mechanically driven thereby through a gear system. In fact, the balance ring 40 is a separate component which may be mounted to any rotary type machine. *Case* makes no mention of a mechanical gear arrangement. There is simply no motivation to modify a completely gear driven vibration absorption system by incorporation of the *Case* balance ring 40 which corrects for eccentric loads and the resultant imbalance.

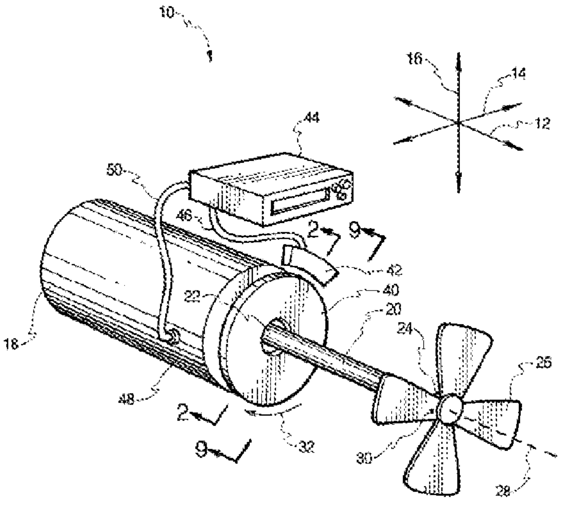
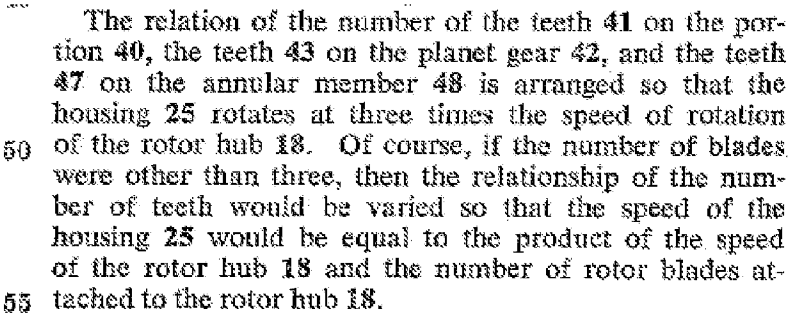


Fig.1

Furthermore, *Case* makes no mention of aircraft which receive vibration from external sources in multiple axes of freedom. These vibrations are constantly changing during aircraft flight – this is not even, under proper interpretation, "balance" compensation as there is nothing to "balance" but only dynamically changing vibrations which to be reduced. Such external vibrations are not relevant to machine tools – or to any non-aircraft system - which are mounted in a fixed position. In fact, any helicopter rotor is balanced and thus vibration does not arise from unbalance but form external forces.

Only the machine shaft (due to wear of the tool; see *Case* ¶¶0006-0008) may be out of balance relative to the fixtured machine typical of a lathe, mill, drill press, grinder, etc. This consistent out of balance condition is what *Case* attempts to compensate for – not changing vibration from external sources. There is simply no motivation to combine a mechanical vibration ***absorption*** system for a helicopter with a balance ***compensation*** system for a fixed machine tool to compensate for tool wear.

As discussed above, *Hooper* discloses a completely mechanical vibration absorption system based on a mechanical gear arrangement. The *Hooper* mechanical vibration absorption system always rotates at a constant ratio with the speed of rotation of the rotor hub. In fact, *Hooper* actually teaches that if the number of blades were other than three, then the relationship of the number of gear teeth must be varied so that the speed of the housing would be equal to the product of the speed of the rotor hub and the number of rotor blades attached to the rotor hub



The relation of the number of the teeth **41** on the portion **40**, the teeth **43** on the planet gear **42**, and the teeth **47** on the annular member **48** is arranged so that the housing **25** rotates at three times the speed of rotation of the rotor hub **18**. Of course, if the number of blades were other than three, then the relationship of the number of teeth would be varied so that the speed of the housing **25** would be equal to the product of the speed of the rotor hub **18** and the number of rotor blades attached to the rotor hub **18**.

[Col. 4, lines 44-55.]

Case may include a controller to consistently compensate for a load imbalance, however, such control is simply inapplicable to *Hooper*. That is, *Hooper* discloses a fixed gear arrangement which cannot be varied by any controller. A fixed gear arrangement is a fixed gear arrangement. There is therefore no benefit to combine the *Case* controller with the purely mechanical gear system of *Hooper*. In fact, there is no motivation whatsoever to combine any controller with the purely mechanical gear system of *Hooper* because such system simply cannot be controlled. That is, the intent of *Hooper* is to passively respond to ambient vibration. It is axiomatic that an obviousness rejection must come from the suggestions or teachings of the references themselves. A proper suggestion or motivation to make a combination requires some benefit to result from the combination. When the additional teachings of a secondary reference do not provide any benefit to the arrangement disclosed in a primary reference, no prima facie case of obviousness exists. Because this combination provides no benefit and is therefore improper, there is no prima facie case of obviousness.

The only motivation to make the proposed combination as proposed is by following the knowledge disclosed within the present invention. This is impermissible usage of hindsight in an attempt to recreate Appellant's device. Accordingly, the claims are properly allowable. That is, in order to establish a prima facie case of obviousness, the Examiner bears the burden of establishing three basic criteria. First, the Examiner must show there was some suggestion or motivation, either in the references themselves or in the knowledge generally available to one skilled in the art, to modify the reference or to combine the teachings. Second, there must be a reasonable expectation for success. Third, the prior art references must teach or suggest all of the claims limitations. See MPEP §2142; *In re Vaeck*, 947 F.2d 488 (Fed. Cir. 1991).

The teachings or suggestion to make the claimed combination and the reasonable expectation of success must be found in the prior art, and not based on the applicant's disclosure. Therefore, making a legal determination of obviousness does not mean that one can "pick and choose among the individual elements assorted prior art references to recreate the claimed invention." *Smithkline Diagnostics, Inc. v. Helena Laboratories Corp*., 858 F.2d 878, 8 USPQ2d 1468 (Fed. Cir. 1988). Rather, the Examiner must show, not that each element existed in the prior art, but that some teaching or suggestion in the references made obvious the invention as a whole. *Carella v. Starlight Archery*, 804 F.2d 135, 231USPQ 644 (Fed. Cir. 1986); *Northern Telecom, Inc. v. Datapoint Corp.*, 908 F.ed 931, 15 USPQ2d 1321 (Fed. Cir. 1990).

There is therefore no motivation to modify *Hooper* in view of *Case et al* for at least these separate reasons:

1. *Hooper* is a completely mechanical gear arrangement which is simply not amenable to incorporation of an MRF fluid system; and
2. *Hooper* is directed to an aircraft which is necessarily a free body which receives vibration from external source in multiple axes of freedom since the aircraft is in flight while *Case* is directed to a machine tool which must necessarily be fixtured during operation.

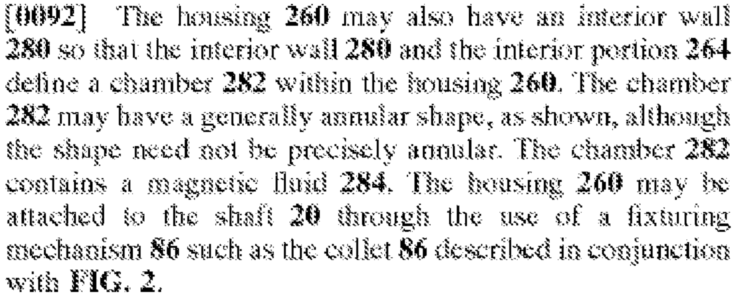
3. *Hooper* is a completely mechanical gear arrangement based on the number of rotor blades such that there can be no benefit to combine any controller therewith since nothing in *Hooper* can be controlled.

Acceptance of any of one of these reasons results in defeat of the proposed combination and all claims are properly allowable.

It is respectfully submitted that the Examiner has not satisfied the burden of proving that there was some suggestion or motivation to combine *Hooper* in view of *Case et al.* Rather, it is respectfully submitted that the Examiner simply located the individual claim limitations in the prior art and recreated the Appellant's invention based upon his own disclosure.

II. The *Case* Reference Ruins a Function of the *Hooper* Reference

The entire rejection must also fail as the secondary reference ruins the function of the base reference. *Case* requires a fixturing mechanism 86 which may, for example, take the form of a collet 86, typical of lathes, mills, and the like with an outer ring 87 connected to a plurality of movable segments 88 that can be actuated inward to grip the shaft 20. Notably, the fixturing mechanism 86 is used to affix the interior opening 65 to the shaft 20. [0064-0065.] The chamber 282 that contains the magnetic fluid 284 of housing 260 is attached to the shaft 20 through the use of this fixturing mechanism 86. [¶0092]



[0092] The housing **260** may also have an interior wall **280** so that the interior wall **280** and the interior portion **264** define a chamber **282** within the housing **260**. The chamber **282** may have a generally annular shape, as shown, although the shape need not be precisely annular. The chamber **282** contains a magnetic fluid **284**. The housing **260** may be attached to the shaft **20** through the use of a fixturing mechanism **86** such as the collet **86** described in conjunction with **FIG. 2.**

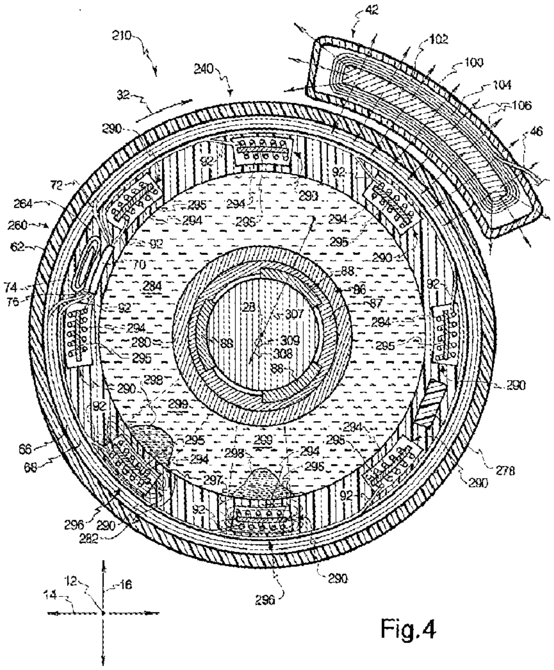


Fig.4

That is, the chamber 282 which contains the magnetic fluid 284 is mounted directly to the fixturing mechanism 86 which removably holds the shaft 20. Such an arrangement is completely inapplicable to the *Hooper* rotor system of a rotary wing aircraft which, of course, does not use a fixturing mechanism or a collet to removably hold the main rotor shaft. The attachment arrangement of *Case* is not compatible with *Hooper* because of the inherent differences between a rotary wing aircraft rotor system and a machine tool. That is, a machine tool such as a lathe, mill, drill press, grinder, etc., typically includes a collet to removably hold the shaft such that the tool attached to the shaft may be readily replaced. Such removability is not only not required for a helicopter main rotor shaft but would be most undesirable as the main rotor shaft and rotor assembly must, at the bare minimum, be reliability secured to the airframe irrespective of external forces during flight. It is improper to modify the base reference in such a way that it ruins the goal or function of the base reference. Because this combination, according to the teachings of *Case*, would require a collet to removably hold the main rotor shaft of *Hooper*, the combination would ruin a most basic function of a rotary wing aircraft – secure retention of the rotor system. The claims are properly allowable for this reason alone.

B. DIFFERENCES BETWEEN THE CLAIMED INVENTION AND THE PROPOSED COMBINATION

Even if the combination of *Hooper* in view of *Case* were properly made – which it is not - there are differences between the claimed invention and the teachings of the cited references so that the combination does not meet the limitations of Appellant's claims.

INDEPENDENT CLAIMS

Claims 12 and 21

I. The Azimuthally Variable Limitation

Claim 12 recites:

> an electromagnetic field generation system mounted adjacent said enclosed chamber to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber to reduce a vibratory load in said rotating system.

Claim 21 recites:

> an electromagnetic field generation system mounted adjacent said enclosed chamber to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber to form an eccentric mass in response to said control system to reduce said NP vibrations.

The *Hooper* gear system rotates only at a constant ratio with respect to the rotational speed of the rotor hub. [See *Hooper*, Col. 8, lines 64-66 and lines 70-73.] The key difference is that Hooper's masses are uncontrolled and thus cannot be commanded to produce a known amplitude and phase. *Hooper* depends upon physics like a tuned vibration absorber for his device to naturally respond to suppress vibration. That is *Hooper* cannot meet the limitation: to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber

This deficiency is not cured by *Case* as the Examiner admits that the *Case* housing rotates with the shaft 20 and does not rotate independently thereto. [12-06-2005 Office Action, page 4]

Since *Hooper* rotates at a constant speed ratio relative to the rotor system and *Case* rotates at a constant speed equivalent of the shaft, *Hooper* in view of *Case* (even if properly combinable) cannot respond to varying flight regimes as disclosed and claimed by Appellant [Also see Appellants specification ¶0035.] Claims 12 and 21 are properly allowable.

DEPENDANT CLAIMS

Claims 29, 30, 31 and 32

Claim 29 Is Patentable Independent Of Its Respective Independent Claim 21

Claim 29 depends from independent claim 21 and recites: a housing mounted to said main rotor system, said enclosed chamber mounted for rotation within said housing. That is, the enclosed chamber 22 partially filled with the MRF 26 rotates within a housing 20.

Even if the proposed combination were properly made - - which it is not - - it fails to disclose or suggest an enclosed chamber 22 filled with MRF 26 mounted for rotation within a housing 20 such as an aerodynamic housing mounted atop the main rotor system. This dependent claim is properly allowable.

Claim 30 Is Patentable Independent Of Its Respective Independent Claim 21

Claim 30 depends from dependent claim 29 and further recites: a drive system located within said housing to drive said enclosed chamber about said axis of rotation.

Even if the proposed combination were properly made - - which it is not - - it fails to disclose or suggest a drive system within a housing to drive the enclosed chamber. *Hooper* and *Case* are respectively driven by the main rotor shaft and the tool shaft 20. Notably, irrespective of the rotation independent of said main rotor system limitation, the cited references do not include a separate drive system such as an electric motor within a housing to drive an enclosed chamber therein. This dependent claim is properly allowable.

Claim 31 Is Patentable Independent Of Its Respective Independent Claim 21

Claim 31 depends from dependent claim 29 and further recites: wherein said electromagnetic field generation system is mounted within said housing adjacent said enclosed chamber.

Even if the proposed combination were properly made - - which it is not - - it fails to disclose or suggest an electromagnetic field generation system between two housings which rotate relative to each other. Notably, *Case* discloses a ring controller 42 mounted ***near*** the balance ring 40. In no embodiment of *Case* does the ring controller 42 rotate. This dependent claim is properly allowable.

Claim 32 Is Patentable Independent Of Its Respective Independent Claim 21

Claim 32 depends from dependent claim 29 and further recites: wherein said housing is mounted to said main rotor system for rotation therewith.

Even if the proposed combination were properly made - - which it is not - - it fails to disclose or suggest a separate housing mounted to said main rotor system for rotation therewith. That is, the outside aerodynamic housing rotates with the main rotor shaft, while the enclosed chamber 22 within the outside aerodynamic housing rotates independent thereof. This dependent claim is properly allowable.

VIII. CONCLUSION

For the above reasons, the rejections by the Examiner should be reversed. The Commissioner is authorized to charge the $500 filing fee to Deposit Account No. 19-2189.

Respectfully Submitted,

CARLSON, GASKEY & OLDS, P.C.

/David L. Wisz/
DAVID L. WISZ
Registration No. 46,350
Attorneys for Appellant
400 West Maple, Suite 350
Birmingham, Michigan 48009
(248) 988-8360

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CLAIMS APPENDIX

12. A vibration isolation system for reducing vibrations in a rotating system which rotates about an axis of rotation, comprising:

an enclosed chamber mounted to the rotating system for rotation about said axis of rotation independent of the rotating system;

a Magneto Rheological Fluid (MRF) at least partially filling said enclosed chamber; and

an electromagnetic field generation system mounted adjacent said enclosed chamber to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber to reduce a vibratory load in said rotating system.

13. The vibration isolation system as recited in claim 12, wherein said enclosed chamber is driven about said axis of rotation at a rotational speed greater than the rotating system.

14. The vibration isolation system as recited in claim 12, wherein said enclosed chamber is driven at an absolute rotational speed of NP in the rotational direction of the rotating system where N is a number of rotor blades mounted to the rotating systems and P is the rotational speed of the rotating system.

15. The vibration isolation system as recited in claim 12, wherein said enclosed chamber is driven at an absolute rotational speed of NP in a rotational direction opposite of the rotating system where N is a number of rotor blades mounted to the rotating system and P is the rotational speed of the rotating system.

16. The vibration isolation system as recited in claim 12, wherein said rotating system includes a main rotor system.

17. The vibration isolation system as recited in claim 12, further comprising a drive system which includes an electric motor to drive said enclosed_chamber about said axis of rotation at a rotational speed greater than the rotating system.

18. The vibration isolation system as recited in claim 17, further comprising a generator which drives said electric motor, a phase of the voltage from said generator providing a phase reference to said control system indicative of a rotational speed of the rotating system.

20. The vibration isolation system as recited in claim 12, wherein said electromagnetic field generation system includes a multiple of electromagnets adjacent said enclosed chamber for rotation therewith.

21. A helicopter rotor system which rotates about an axis of rotation, comprising:

a main rotor system having an N number of blades which rotates about an axis of rotation at a rotational speed of 1P, such that said main rotor system produces NP vibrations;

an enclosed chamber mounted to said main rotor system for rotation about said axis of rotation independent of said main rotor system;

a Magneto Rheological Fluid (MRF) at least partially filling said enclosed chamber;

a sensor system which senses the NP vibrations;

a control system in communication with said sensor system, said control system operable to identify variations of the NP vibrations; and

an electromagnetic field generation system mounted adjacent said enclosed chamber to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber to form an eccentric mass in response to said control system to reduce said NP vibrations.

22. The helicopter rotor system as recited in claim 21, further comprising a drive system which includes an electric motor to drive said enclosed chamber about said axis of rotation at an absolute rotational speed of NP in the direction of the main rotor assembly.

23. The helicopter rotor system as recited in claim 21, further comprising a drive system which includes an electric motor to drive said enclosed chamber about said axis of rotation at an absolute rotational speed of (N+1)P in a direction opposite of the main rotor assembly.

24. A method of reducing vibrations in a helicopter rotor system which rotates about an axis of rotation comprising the steps of:

(1) rotating an enclosed chamber mounted to a main rotor system about the axis of rotation independent of the main rotor system, the enclosed chamber at least partially filled with a Magneto Rheological Fluid (MRF);

(2) sensing a vibration generated by the main rotor system;

(3) varying an electromagnetic field about the enclosed chamber to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber to form an eccentric mass in response to said step (2) to reduce the vibration; and

(4) varying an electric motor speed that rotates the enclosed chamber to match an optimal phase relative the vibration in response to controller commands.

25. A method as recited in claim 24, wherein said step (3) further comprises:
varying the electromagnetic field in response to a predefined schedule.

26. A method as recited in claim 24, wherein said step (3) further comprises:

(a) sensing a trend in a variation of the vibrations generated by the main rotor system; and

(b) varying the electromagnetic field in response to the trend.

27. A method as recited in claim 24, wherein said step (3) further comprises:

(a) forming the eccentric mass within the enclosed chamber in an azimuthal position about the axis of rotation in response to a commanded strength of the electromagnetic field position.

28. A method as recited in claim 24, wherein said step (4) further comprises the steps of:

(a) mechanically driving a generator in response to a speed of the main rotor system, the rotational speed of the generator being a fixed multiple of the speed of the main rotor system NP frequency;

(b) driving the electric motor with the generator to rotate the enclosed chamber;

(c) determining a phase reference signal from a voltage of the generator to indicate a rotational speed of the main rotor system; and

(d) determining the optimal phase of the electric motor from the phase reference signal.

29. The helicopter rotor system as recited in claim 21, further comprising a housing mounted to said main rotor system, said enclosed chamber mounted for rotation within said housing.

30. The helicopter rotor system as recited in claim 29, further comprising a drive system located within said housing to drive said enclosed chamber about said axis of rotation.

31. The helicopter rotor system as recited in claim 29, wherein said electromagnetic field generation system is mounted within said housing adjacent said enclosed chamber.

32. The helicopter rotor system as recited in claim 29, wherein said housing is mounted to said main rotor system for rotation therewith.

33. A helicopter rotor system which rotates about an axis of rotation, comprising:

a main rotor system having an N number of blades which rotates about an axis of rotation at a rotational speed of 1P, such that said main rotor system produces NP vibrations;

a housing mounted to said main rotor assembly;

an enclosed chamber mounted within said housing for rotation about said axis of rotation independent of said main rotor assembly;

an electric motor located within said housing to drive said enclosed chamber about said axis of rotation independent of said main rotor assembly;

a Magneto Rheological Fluid (MRF) at least partially filling said enclosed chamber;

a sensor system which senses the NP vibrations;

an electromagnetic field generation system mounted adjacent said enclosed chamber to azimuthally vary a viscosity of said MRF and distribute said MRF within said enclosed chamber to form an eccentric mass; and

a control system in communication with said sensor system, said electric motor, and said electromagnetic field generation system, said control system operable to identify variations of the NP vibrations to control a rotational speed of said enclosed chamber and said electromagnetic field generation system to control distribution of said MRF within said enclosed chamber to reduce the NP vibrations.

34. The system as recited in claim 33, further comprising a generator driven by said main rotor system which powers said electric motor, a phase of the voltage from said generator providing a phase reference to said control system indicative of a rotational speed of the said main rotor system.

RELATED PROCEEDINGS APPENDIX

There are no related proceedings.

RELATED EVIDENCE APPENDIX

None.